

Method and Device for Object Detection

## Background Information

A method for object detection having at least two distance-determining sensors attached to a motor vehicle, the detection regions at least partially overlapping and relative positions of possible detected objects with respect to the sensors in the overlap region being determined according to the triangulation principle, is known to the Applicant from German Patent Application DE 199 49 409 A1. Possible apparent objects resulting from object determination are identified in this process via dynamic object monitoring. Such known methods for determining the position of objects use the distance lists of similar individual sensors as input quantities. In this context, similar means that these individual sensors have the same aperture angle. The maximum horizontal sensing range of typical sensors of this type is +/- 55 degrees, for example. Therefore, at a distance of approximately 14m, each sensor covers a region of approx. +/- 6m in the lateral direction. This means that numerous interfering objects on the road edge, such as trees, bushes, or posts, are sensed in addition to relevant objects, such as traffic members. Moreover, significant measurement data was used to determine that a plurality of reflection centers may be detected even for relevant objects so that it is not ensured that every sensor is detecting the same reflection center. As a result of these facts, it is not ensured for all traffic situations that relevant and interfering objects are able to be clearly identified even when using more than two sensors. It is also possible for objects to be displayed at incorrect positions.

## Advantages of the Invention

The present invention relates to a further improvement of the known and proven method that is capable of further increasing the reliability. The improved differentiation ability between relevant objects and interfering objects allows the position of relevant objects to be determined even more precisely. In addition, the concentration of at least one sensor on the own road region makes it possible to increase the coverage while maintaining the same radiated power.

## 10 Drawing

The method according to the present invention and the device according to the present invention are explained on the basis of the exemplary embodiments in the drawing. The figures show: Figure 1 shows use of the conventional method for a traffic situation on a roadway having a plurality of lanes; Figure 2 shows use of the method of the present invention for a traffic situation on a roadway having a plurality of lanes.

## 20 Description of the Embodiments

The method known per se including its disadvantages still present in very unfavorable conditions is explained on the basis of Figure 1. Shown is a traffic situation on a roadway 10, which includes a plurality of lanes 10.1, 10.2, 10.3. Own vehicle 1 travels in center lane 10.2 and approaches two other vehicles 3 and 4 traveling in the same direction in adjacent lanes 10.1 and 10.3. Vehicle 1 is equipped with distance sensors S1, S2, S3, the at least partially overlapping sensing ranges being designated as ES1, ES2, ES3. Under particularly unfavorable conditions, the detection of different reflection centers may result in the system as a whole displaying a non-existent apparent target in addition to vehicles 2 and 3. Such an apparent target appears to be in region 4, i.e., in lane 10.2 of own vehicle 1. The edge regions of sensing ranges ES1, ES2, ES3 overlap in region 4. Such a result clearly leads to a false reaction of the system, i.e., the vehicle would react

with a braking operation. This would result in significant uncertainty on the part of the driver of vehicle 1 since the driver, trusting the system display, erroneously believes that an obstacle is located in front of own vehicle 1 in own lane 10.2 of roadway 10 in region 4. As soon as the driver determines that this is a system error, trust in the system reliability may be lost.

The method according to the present invention is explained on the basis of Figure 2. Shown is a traffic situation comparable to that in Figure 1. On a roadway 10, including a plurality of lanes 10.1, 10.2, 10.3, own vehicle 1 travels in center lane 10.2 and approaches two other vehicles 3 and 4 traveling in the same direction in adjacent lanes 10.1 and 10.3. Vehicle 1 is equipped with distance sensors S1, S2, S3, the at least partially overlapping sensing ranges being designated as ES1, ES2, ES3. At least two sensors, namely sensors S1, S3, are positioned at the front of the vehicle essentially in one plane. A third sensor S2 is also positioned at the vehicle front between sensors S1 and S3. Sensing ranges ES1 and ES3 of sensors S1 and S3 largely overlap. Their angular expansion on a horizontal plane is approx.  $\pm 55^\circ$ , for example. This means that at a distance of approximately 14m from the front of vehicle 1, each sensor S1, S3 having sensing range ES1, ES3 in the lateral direction covers a region of approximately  $\pm 6m$ . Therefore, in the case of multi-lane roadway 10 shown in Figure 2, at least partial regions of adjacent lanes 10.1 and 10.3 are covered in addition to own lane 10.2. In the case of a narrower road having for example only one lane for each direction, sensing ranges ES1, ES3 of sensors S1, S3 would sense the edges of the road and obstacles present there in addition to the adjacent lane. According to the present invention, at least one sensor S2 has a sensing range ES2, the angular expansion of which is significantly less than that of sensing ranges ES1 and ES3. The angular expansion of sensing range ES2 is preferably so small that essentially only own lane 10.2 is covered for the maximum sensing range as shown in

Figure 2. Such a limitation of the horizontal sensing range of sensor S2 allows a selection of relevant object reflections to be made under the assumption that objects outside own lane 10.2, i.e., vehicles 2 and 3 in lanes 10.1 and 10.3, are no longer detected by sensor S2. An object is namely generated or triangulated when it is detected by at least two sensors. If the point of intersection of the sensing ranges of sensors S1 and S3 are in sensing range ES2 of sensor S2 but sensor S2 does not detect an object, no object is generated in sensing range ES2. The result is that the distance values detected by sensors S1 and S3 cannot be from the same object. Accordingly, preferably only objects detected by sensors S1, S3 as well as by sensor S2 are viewed as relevant targets. These are almost exclusively objects located in own lane 10.2. In the traffic situation shown in Figure 2, no object to be classified as relevant would be displayed according to this. Even the representation of an apparent target may be effectively suppressed even under particularly unfavorable conditions.

As a result of the possible focusing of the beam of sensor 2, its sensing range ES2, as shown in Figure 2, may extend significantly farther in the travel direction of vehicle 2 than sensing ranges ES1 and ES3 of sensors S1, S3. This is possible without increasing the radiated power. The focusing may be performed in a relatively simple manner via correspondingly dimensioned optical elements, such as lenses, positioned in the beam path. Since greater sensing range ES2 of sensor S2 in the travel direction of vehicle 2 allows early selective sensing of objects located in own lane 10.2, a triangulation and/or tracking algorithm provided in the system or a filter method may be advantageously preconditioned. This results in a time advantage that contributes to an increase in safety particularly in critical situations.

In an advantageous further embodiment of the present invention, sensing ranges ES1 and ES3 of sensors S1, S3, which are responsible for the peripheral regions, may be further

adjusted such that as few non-relevant objects as possible are detected. Therefore, the sensing coverage of sensing ranges ES1 and ES3 may be preferably shortened such that vehicles approaching own lane 10.2 may be detected early but far away objects on the road edge are no longer detected. The sensing range in the immediate vicinity of vehicle 2 is not significantly affected by the described measures so that parking operations continue to be reliably supported.

The solution of the present invention may be implemented in an essentially cost-neutral manner since already available standard sensors only need to be adapted accordingly. A sensor functioning in another frequency range, e.g. 77 GHz band, already proven in an ACC system (ACC = Automatic Cruise Control) may be used in some instances for sensor S2.

In an advantageous further embodiment of the present invention, the sensing angle and/or sensing coverage of sensing range ES2 of sensor 2 is/are adaptable to the particular road conditions such that an optimal adjustment to the road type and the dependent width of the existing lanes results. As a result, sensing range ES3 may be optimally adapted to roadways having only a single lane or a plurality of lanes. This adjustment may be performed manually by the driver who operates a corresponding switch having a plurality of switch positions when entering a certain road category, e.g. when merging onto a highway. However, in a particularly advantageous manner, sensing range ES2 may also be automatically adapted to the road category, e.g. via coupling with a navigation system provided in vehicle 2 or via a GPS system. As soon as the navigation system determines that a certain road type is being driven on, a corresponding adjustment signal is sent to the system for determining the position of objects.

In a further advantageous embodiment of the present invention, such an adjustment of sensing range ES2 is performed by the

system for determining the position of objects in that in particular the signals of sensors S1 and S3, which are responsible for the peripheral regions, are evaluated accordingly. If for example these sensors sense a large number  
5 of objects in their sensing ranges, it may be derived that the particular sensing range extends too far beyond the edge region of the road. The width of the sensing range would then be able to be reduced automatically.

### List of reference numerals

1	First vehicle
2	Second vehicle
3	Third vehicle
4	Apparent object
10	Roadway
10.1	First lane
10.2	Second lane
10.3	Third lane
S1	First sensor
S2	Second sensor
S3	Third sensor
ES1	Sensing range sensor 1
ES2	Sensing range sensor 2
ES3	Sensing range sensor 3
EW	Sensing angle